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(56) Documents Cited
GB 1349218 A **EP 0496170 A2** **EP 0183380 A2**

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(54) Screw pump

(57) A pump (10) for pumping fluid consisting of liquid with a variable volume of entrained air or gas includes a fluid inlet (25) to a walled fluid passage (36) and a fluid outlet therefrom with at least one bleed port (40) in the wall at an intermediate point in the fluid passage. At least two parallel interacting helical screw rotors are rotatably mounted within the fluid passage (36) and extend from the fluid inlet (25) to the fluid outlet (55), the rotors having a higher pumping flow rate between the fluid inlet (25) and the intermediate point than between the intermediate point and the fluid outlet. The pump can operate effectively with void volumes between 0% and 100%.

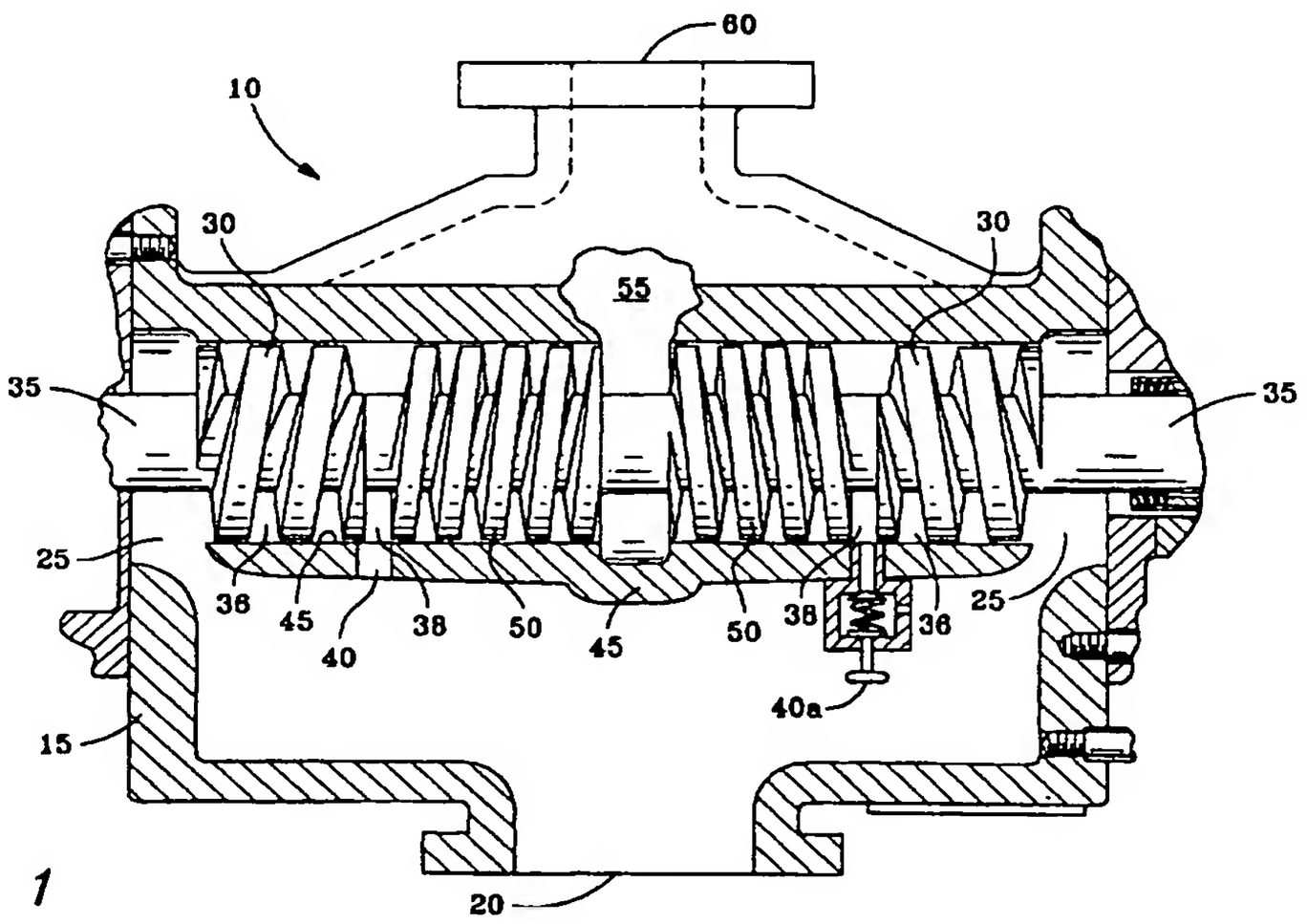

FIG. 1

At least one drawing originally filed was informal and the print reproduced here is taken from a later filed formal copy.

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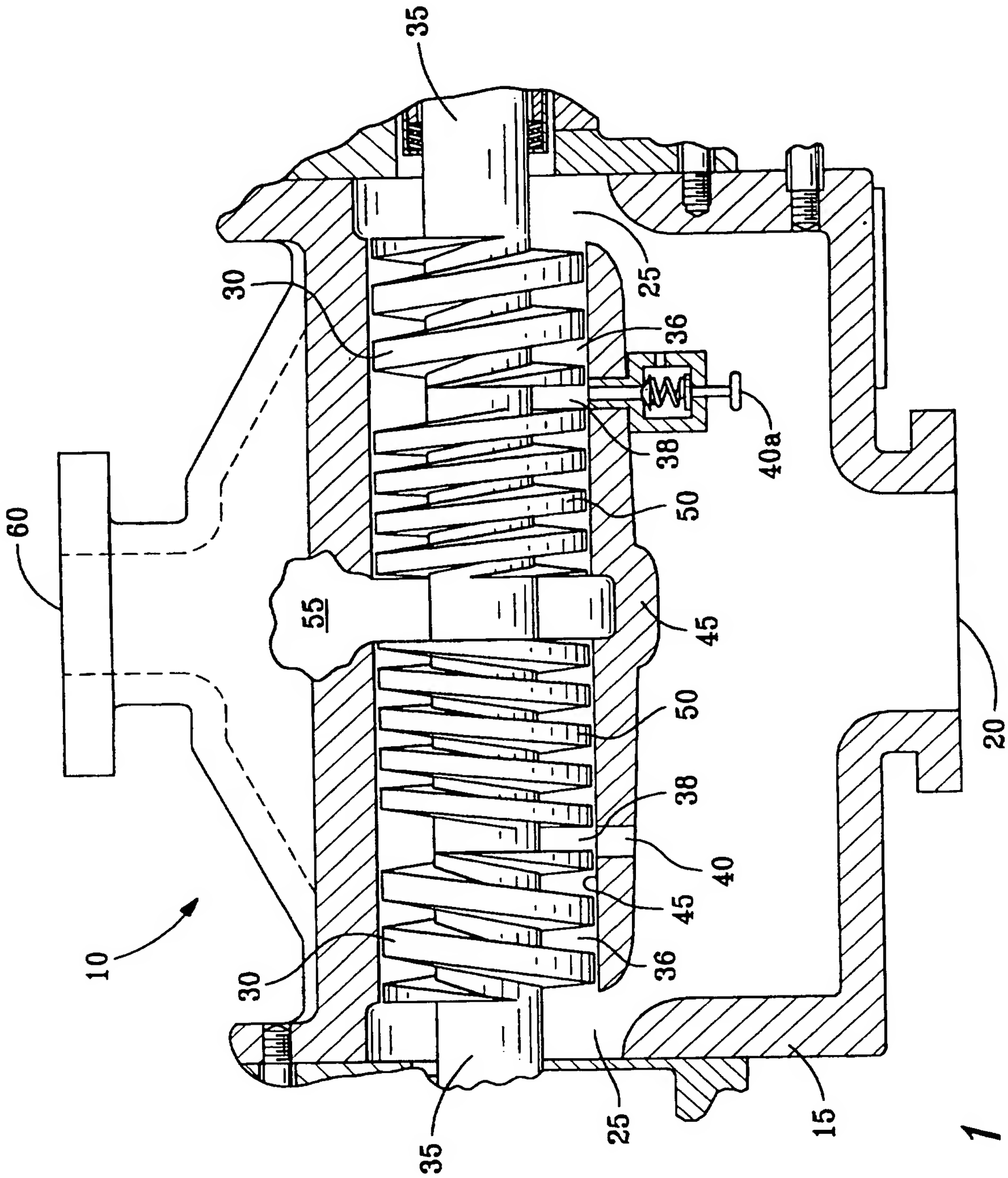

FIG. 1

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DUAL PITCH MULTIPHASE SCREW PUMP

This invention relates generally to screw pumps and more particularly to positive displacement screw pumps having more than one screw pitch for handling liquids with variable volumes of entrained gases.

Positive displacement screw pumps are widely applied for pumping a variety of fluids having widely variable pumping characteristics. A non-compressible liquid having a variable gas content presents a problem, in that a typical two screw pump handles it with widely variable efficiency. When it encounters a large gas volume (or void) such a pump is inefficient; because it is limited in the amount of compression it can impart to a gas. This leads to wasted energy and a requirement for a larger pump for a given liquid pumping capacity - a penalty in both efficiency and capacity.

A compressor works well for compressing (and pumping) gas, but it cannot handle a slug of incompressible liquid. If it were possible to assure that fluids of only one phase would be encountered, by separation prior to pumping or by some other device, then it would be possible to use a compressor for gas and a positive displacement pump for liquids.

In many cases, such segregation is not practical, if even possible, and liquid pumping efficiency and capacity must be sacrificed in order to accommodate an unpredictable and variable gas volume. A centrifugal pump or other non-positive displacement pump may be used, but it would be severely limited with respect to both pressure and capacity

at the same size and rating as a positive displacement pump.

According to a first aspect of the present invention, there is provided a pump for pumping fluids, comprising a housing having a fluid inlet, a fluid discharge, a walled fluid passage between said fluid inlet and said fluid outlet, and at least one bleed port through said wall at an intermediate point in said fluid passage; at least two parallel interacting helical screw rotors rotatably mounted within said fluid passage and extending from said fluid inlet to said fluid discharge, said rotors having means for pumping at a first flow rate between said fluid inlet and said intermediate point and at a second flow rate, less than said first flow rate, between said intermediate point and a point nearer said fluid discharge than said intermediate point; and means for rotatably driving said rotors.

According to a second aspect of the present invention, there is provided a pump for pumping liquids, comprising a pump housing having a fluid inlet, a fluid discharge, and a walled fluid passage therebetween; at least two parallel interacting helical screw rotors rotatably mounted within said fluid passage, said at least two rotors having a high screw pitch adjacent said fluid inlet and extending to an intermediate point in said fluid passage and a lower screw pitch extending from said intermediate point to said fluid discharge; at least one bleed port through the wall of said fluid passage at said intermediate point; and means for rotatably driving said at least two rotors.

According to a third aspect of the present invention, there is provided a pump for pumping a liquid having a variable volume of entrained gas, comprising a pump housing having a fluid inlet, a fluid discharge, and a walled fluid passage therebetween; at least two parallel interacting helical screw rotors rotatably mounted within said fluid passage, said at least two rotors having means for pumping at a high volumetric flow rate from said fluid inlet to an intermediate point in said fluid passage and for pumping at a lower volumetric flow rate from said intermediate point to said fluid discharge; means for regulating volume and pressure of fluid which passes said intermediate point and enters flights of said means for pumping at a lower volumetric flow rate; and means for rotatably driving said at least two rotors.

According to a fourth aspect of the present invention, there is provided a pump for pumping a liquid having a variable volume of entrained gas, comprising a pump housing having a fluid inlet, a fluid discharge, and a walled fluid passage therebetween, said walled fluid passage having a fluid inlet plenum at each end, a fluid outlet plenum, connected to said fluid discharge, at the centre of said fluid passage, and at least two bleed ports through said wall, one said bleed port each at an intermediate point between said fluid inlet plenum and said fluid outlet plenum; at least two parallel interacting helical screw rotors rotatably mounted within said fluid passage, said at least two rotors having means for pumping at a high volumetric flow rate from said fluid inlet plenums to intermediate points in said fluid passage and for pumping at a lower volumetric flow rate from said intermediate points to said fluid outlet plenum; means for regulating

volume and pressure of fluid which passes said intermediate points and enters flights of said means for pumping at said lower volumetric flow rate; and means for rotatably driving said at least two rotors.

For a better understanding of the present invention and to show how the same may be carried into effect, reference will now be made to the accompanying drawing, in which the single Figure is a fragmentary, schematic, partially sectional, elevation view showing one rotor of at least two included in a positive displacement screw pump.

Figure 1 is a view which shows a pump 10 having a housing 15 with a bottom feed 20, a top outlet 60 and an inlet 25 leading from the feed 20 to a fluid passage 36. The feed 20 and outlet 60 are shown at the top and bottom, respectively, for ease of illustration, and it will be appreciated that the feed and outlet may be placed in any appropriate location without affecting the pump function. The fluid passage 36 extends from the inlet 25 to a discharge outlet 55. A rotor comprising a shaft 35 with a high pitch helical screw flight in a first stage 30 and a low pitch helical screw flight in a second stage 50 is rotatably mounted within the passage 36 and reaches from the inlet 25 to the outlet 55. It should be noted that the Figure shows only one rotor (shaft 35, and the helical screw first stage 30, and second stage 50); but there is another rotor behind the first, the flights of which are meshed with those of the visible rotor for positive displacement. Also, the rotor is shown with end-to-end symmetry for pumping from both ends to the middle, a preferred embodiment. It could, however, be made with only a single suction and a single discharge at opposite ends of the shaft.

At an intermediate point 38 of the passage 36, a bleed port 40 penetrates a wall 45 of the passage and serves as a relief for the spike of liquid volume and pressure which occurs whenever the void fraction of the pumped fluid becomes zero. Bleed fluid may be discarded, drained to a sump for recycling, recirculated directly to the inlet 25 for re-pumping, or handled otherwise. Direct recirculation to the inlet 25 is a preferred embodiment; because it has the potential to reduce power consumption for suction of fluid from the inlet 25 into the passage 36 while maintaining pumping efficiency.

In operation, the shaft 35 is rotatably driven by a motor or other means which is not shown. Packing, bearings, couplings and drive means are well known and are not therefore shown.

Rotation of the rotor causes the first stage 30 to draw fluid in the inlet 25 into passage 36 at a high volumetric pumping rate. If there is any entrained gas in the fluid, it is compressed and pumped with the liquid fraction along the passage 36. Upon reaching the intermediate point 38, the pumped fluid encounters the second stage 50, and, since the shaft 35 is one piece, the pumping rate undergoes a step decrease due to the decrease in flight pitch. An instantaneous pressure spike, which is inversely proportional to the gas or void fraction of the fluid and directly proportional to the compression ratio, is generated due to the incompressibility of the liquid.

At the intermediate point 38, at least one bleed port 40 through the wall 45 of the passage 36 is provided to relieve the pressure spike without damaging the pump or the

drive means. A pressure relief valve 40a is provided in the bleed port or elsewhere in the bleed system to set a minimum desired pump pressure. As long as gas content is sufficient to maintain pressure at the intermediate point 38 below the set point of the relief valve, the valve remains closed and no bleed occurs through the bleed port 40. This assures that the pump will always operate at its maximum pumping capacity in spite of the unpredictably variable gas or void fraction, because the relief valve may be set at maximum pressure which is less than that which would damage the pump.

In operation, the pump consumes less power than standard single pitch pumps, and it can pump effectively with void volumes between 0% and 100% allowing use of smaller pumps than normally required.

CLAIMS:

1. A pump for pumping fluids, comprising a housing having a fluid inlet, a fluid discharge, a walled fluid passage between said fluid inlet and said fluid outlet, and at least one bleed port through said wall at an intermediate point in said fluid passage; at least two parallel interacting helical screw rotors rotatably mounted within said fluid passage and extending from said fluid inlet to said fluid discharge, said rotors having means for pumping at a first flow rate between said fluid inlet and said intermediate point and at a second flow rate, less than said first flow rate, between said intermediate point and a point nearer said fluid discharge than said intermediate point; and means for rotatably driving said rotors.

2. A pump for pumping liquids, comprising a pump housing having a fluid inlet, a fluid discharge, and a walled fluid passage therebetween; at least two parallel interacting helical screw rotors rotatably mounted within said fluid passage, said at least two rotors having a high screw pitch adjacent said fluid inlet and extending to an intermediate point in said fluid passage and a lower screw pitch extending from said intermediate point to said fluid discharge; at least one bleed port through the wall of said fluid passage at said intermediate point; and means for rotatably driving said at least two rotors.

3. A pump according to claim 1 or 2, further comprising means for recirculating fluid which bleeds through said at least one bleed port back to said fluid inlet.

4. A pump according to claim 1, 2 or 3, further comprising means for controlling a pressure at which fluid bleeds through said at least one bleed port.

5. A pump for pumping a liquid having a variable volume of entrained gas, comprising a pump housing having a fluid inlet, a fluid discharge, and a walled fluid passage therebetween; at least two parallel interacting helical screw rotors rotatably mounted within said fluid passage, said at least two rotors having means for pumping at a high volumetric flow rate from said fluid inlet to an intermediate point in said fluid passage and for pumping at a lower volumetric flow rate from said intermediate point to said fluid discharge; means for regulating volume and pressure of fluid which passes said intermediate point and enters flights of said means for pumping at a lower volumetric flow rate; and means for rotatably driving said at least two rotors.

6. A pump according to claim 5, wherein the means for regulating volume and pressure of fluid which passes said intermediate point and enters said means for pumping at a lower volumetric flow rate comprises at least one bleed port through the wall of said fluid passage and a pressure relief valve for limiting pressure at said intermediate point.

7. A pump according to claim 6, further comprising means for recirculating fluid which bleeds through said bleed port back to said fluid inlet.

8. A pump according to claim 5, wherein the means for regulating volume and pressure of fluid which passes said

intermediate point and enters flights of said means for pumping at a lower volumetric flow rate comprises a bleed port through the wall of the fluid passage at said intermediate point, a bleed plenum outside and surrounding the fluid passage wall, a pressure relief valve limiting pressure within said bleed plenum, and means for recirculating fluid which bleeds from said bleed plenum back to said fluid inlet.

9. A pump for pumping a liquid having a variable volume of entrained gas, comprising a pump housing having a fluid inlet, a fluid discharge, and a walled fluid passage therebetween, said walled fluid passage having a fluid inlet plenum at each end, a fluid outlet plenum, connected to said fluid discharge, at the centre of said fluid passage, and at least two bleed ports through said wall, one said bleed port each at an intermediate point between said fluid inlet plenum and said fluid outlet plenum; at least two parallel interacting helical screw rotors rotatably mounted within said fluid passage, said at least two rotors having means for pumping at a high volumetric flow rate from said fluid inlet plenums to intermediate points in said fluid passage and for pumping at a lower volumetric flow rate from said intermediate points to said fluid outlet plenum; means for regulating volume and pressure of fluid which passes said intermediate points and enters flights of said means for pumping at said lower volumetric flow rate; and means for rotatably driving said at least two rotors.

10. A pump, substantially as hereinbefore described, with reference to the accompanying drawing.

The Patent Office

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Claims searched: 1-10

Examiner: C J Duff
Date of search: 24 June 1996

Patents Act 1977
Search Report under Section 17

Databases searched:

UK Patent Office collections, including GB, EP, WO & US patent specifications, in:

UK Cl (Ed.O): F1F(FEW)

Int Cl (Ed.6): F04C

Other: ON-LINE: WPI

Documents considered to be relevant:

Category	Identity of document and relevant passage	Relevant to claims
A	GB 1349218 (DAVEY) Whole document	
A	EP 0496170 A2 (JAMES RIVER) Whole document	
X	EP 0183380 A2 (STOTHERT & PITT) See page 4, lines 16-29	5

X	Document indicating lack of novelty or inventive step	A	Document indicating technological background and/or state of the art.
Y	Document indicating lack of inventive step if combined with one or more other documents of same category.	P	Document published on or after the declared priority date but before the filing date of this invention.
&	Member of the same patent family	E	Patent document published on or after, but with priority date earlier than, the filing date of this application.